ANL/ES-C2017-17083

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CFD Study of Impact of Part-to-Part Variations on Spark-Ignition Engine Charge Formation

Final CRADA Report

Energy Systems

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Final CRADA Report

prepared by
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Participants: Ford Motor Company

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Non Proprietary

Final CRADA Report

For the Office of Scientific and Technical Information (OSTI)

CRADA Number: 2017-17083
CRADA Title: CFD Study of Impact of Part-to-Part Variations on Spark-Ignition Charge Formation
CRADA Start Date 5/31/2017 – **End Date** 11/30/2018

DOE Program or Other Government Support
Program office: EERE AMO
Program manager name: Lori Diachin
Program manager phone or email: diachin2@anl.gov

Participant(s)

Participant 1 name: Ford Motor Company
Complete address: 1 Americal Road, Dearborn, MI 48126

Participant 2 name: Click or tap here to enter text.
Complete address: Click or tap here to enter text.

Participant 3 name: Click or tap here to enter text.
Complete address: Click or tap here to enter text.

Argonne National Laboratory

Argonne PI(s): Sibendu Som

Funding Table

To add rows, right-click in bottom row and select “Insert” “rows above”.

	Planned Funding	Actual Funding	In-Kind
Government	$300,000	$300,000	
Enter Participant 1 here	$	$	$70,000
Enter Participant 2 here	$	$	$
Enter Participant 3 here	$	$	$
Total	**$300,000**	**$300,000**	**$70,000**

Nature of Work

Describe the research (summary of Scope of Work and principal objectives of the CRADA):

Spark-ignition engines are the backbone behind people transportation around the world. The efficiency of spark-ignition engines is limited in practice by variations between engine cycles and cylinders within an engine that result from the manufacturing processes/tolerances. These variations impact knock limits and dilution tolerance, which results in more conservative settings for design and calibration settings, such as compression ratio, valve timing, and exhaust gas recirculation rates. Engine variations also have a significant impact on emissions generation, which can have a secondary impact on efficiency. A deeper understanding of the relative importance of these variations and their interactions on the charge preparation process can guide future decisions on machining tolerances and control strategies. This project will develop simulation tools and methodology to include the effects of some key manufacturing tolerances and their impact on engine performance and emissions.

DOE mission area(s):
Energy and Environmental Science and Technology
Mathematics and Computer Sciences
Choose an item.

Conclusions drawn from this CRADA; include any major accomplishments:
Physics-based modeling was instrumental in identifying the effects of engine tolerances on performance and stability. Simulation results were used to analyze the root causes of the sensitivity of engine performance to manufacturing tolerances. High-fidelity numerical simulations were used to evaluate the effects of 3 different manufacturing tolerances – intake port tolerances, spark plug orientation, and fuel injector tolerances – on engine performance and stability. The major conclusions from this study are as follows:

1. It was shown that the numerical simulations were able to accurately predict engine performance and stability for the nominal operating conditions.
2. Numerical simulation was shown to be sensitive to minor changes to the computational geometry imposed by manufacturing tolerances.
3. It was found that the engine performance and stability was strongly affected by manufacturing tolerances in the intake port whereas the effects of injector tolerances were not that significant.

The results from this project led to one conference paper and one journal paper under preparation.

Technology Transfer-Intellectual Property
Argonne National Laboratory background IP:
Parallel Perturbation Methodology (PPM), which was developed at Argonne, was used to perform some of the simulations in this project. Argonne has a software copyright on this technology.

Participant(s) background IP:
Click or tap here to enter text.

Identify any new Subject Inventions as a result of this CRADA:
Click or tap here to enter text.

Summary of technology transfer benefits to industry and, if applicable, path forward/anticipated next steps towards commercialization:
No commercialization plans

Other information/results (papers, inventions, software, etc.):
This project led to 1 conference paper:
Chen, C., Ameen, M. M., Wei, H., Iyer, C., Ting, F., Vanderwege, B., & Som, S. (2019). *LES Analysis on Cycle-to-Cycle Variation of Combustion Process in a DISI Engine* (No. 2019-01-0006). SAE Technical Paper.
One journal paper is under preparation and will be submitted to International Journal of Engine Research.

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